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Addressing water challenges on the North China Plain with hydroeconomic optimization

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With its diverse environment and large population, China is facing water resource challenges, both in terms of quantity and quality. The North China Plain (NCP) is one of the world's most densely populated areas and one of the highly water stressed regions of China. It counts for 15% of the Chinese GDP, from both industry and agriculture. The high water demand for especially irrigation has caused decade long groundwater depletion, ecosystem deterioration and high pollution loads in the region. To alleviate the water crisis of Northern China the South-North Water Transfer Project has been constructed. However, the project alone cannot solve the NCP's water crisis.

A hydroeconomic optimization model has been developed for the NCP system. The model area represents the administrative area of the Hai River Commission. The challenges addressed are the spatio-temporal distribution of costs and curtailments from achieving a sustainable water allocation policy, especially focusing on groundwater abstraction and ecological minimum flows. Efficient linear programming solvers (LP) are used to enable adequate representation of the physical water delivery system and to move away from system simplifications. This enables the representation of links and interactions between the water resources system and the power system of Northern China. The multi-reservoir LP model is formulated as a flow path based optimization, which tracks each water delivery from supplier to receiver. This is useful for the exploration of optimal water allocation as well as water trading policies and other economic measures. The suggested setup is a move towards a more applicable and implementable model.

A baseline run producing business-as-usual costs and deliveries across space and time is presented and compared with a model run including sustainability constraints. This shows changes in allocations and costs of ending groundwater depletion and keeping water quality criteria. It further reflects the conflict between sustainability and economic output of the energy, food and industrial sectors in a water resource management framework.